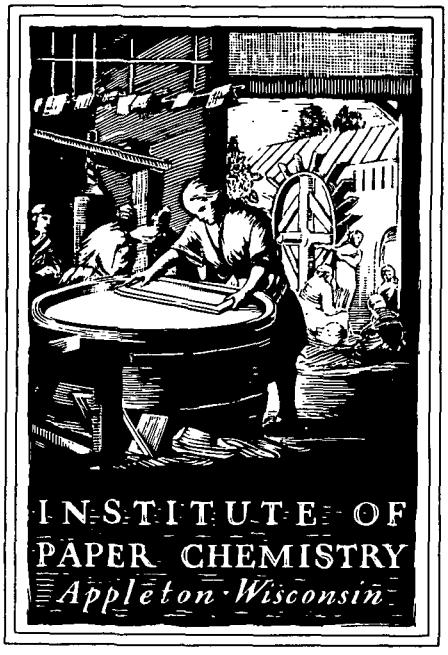
PROJECT ADVISORY COMMITTEE

Subcommittee on

Systems Analysis



IPC STAFF STATUS REPORTS

This information represents a review of on-going research for use by the Project Advisory Subcommittees. The information is not intended to be a definitive progress report on any of the projects and should not be cited or referenced in any paper or correspondence external to your company.

Your advice and suggestions on any of the projects will be most welcome.

FOR MEMBER COMPANIES ONLY

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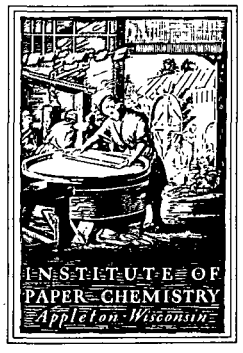

THE INSTITUTE OF PAPER CHEMISTRY
Post Office Box 1039
Appleton, Wisconsin 54912
Phone: 414/734-9251
FAX: 414/738-3448
Telex: 469289

September 30, 1988

TO: Members of the Systems Analysis Project Advisory Committee

Enclosed is advance reading material for the October 25-26 meeting of the Systems Analysis Project Advisory Committee. Included is the status report, an agenda, and a current committee membership list.

Rooms have been reserved in the Continuing Education Center, and meals will be provided as stated on the agenda. If you haven't already indicated your attendance, please do so at your earliest convenience by returning your registration form or calling Jennifer Schuh at 414/738-3320. Also enclosed is the Security Card with the number to gain entrance into the Continuing Education Center.

For all Project Advisory Committee meetings, the Institute invites its member companies to send one or more representatives to attend the review sessions (first day) of any or all of the meetings. PAC members from member companies are also welcome to attend the other meetings, and may stay in the CEC and attend meetings and meals of their choice, at no cost. If you wish to attend any of the other meetings, but haven't registered, please call Jennifer Schuh to do so. A meeting schedule is enclosed for your information.

We look forward to meeting with you on October 25-26.

Sincerely,

Clyde H. Sprague, Director
Engineering Division

CHS/lms
Enclosures

THE INSTITUTE OF PAPER CHEMISTRY

Project Advisory Committee Fall Meetings
Member Dues - Funded Research Reviews

October 18, 19, 20, 25, and 26

1988

Continuing Education Center
Appleton, Wisconsin
(414) 734-9251

Committee	Review Schedule	Research Area*
Pulping Processes	Tuesday, October 18 8:30 AM - 5:30 PM Dinner at 6:00 PM	Kraft Chemical Recovery Furnace Processes Chemical Pulp Alkali Pulping Oxygen Bleaching Chlorinated Organics Analytical Techniques Analysis of Chlorinated Organics Microstructure of Wood Fibers High Lignin Pulps Photochemistry
Paper Properties	Wednesday, October 19 8:30 AM - 5:30 PM Dinner at 6:00 PM	Board Properties and Performance Process, Properties, Product Relationships Internal Strength Enhancement Strength Improvement and Failure Mechanisms On-line Measurement of Paper Mechanical Properties Fundamentals of Paper Surface Wettability
Engineering	Thursday, October 20 10:00 AM - 5:30 PM Dinner at 6:00 PM	Corrosion Recovery Boiler Fireside Corrosion Kraft Liquor Corrosivity Suction Roll Failures Corrosion-Resistant Coatings Papermaking Displacement Pressing Wet Pressing Impulse Drying

*Not in order of agenda

Committee	Review Schedule	Research Area*
Systems Analysis	Tuesday, October 25 1:00 PM - 5:30 PM Dinner at 6:00 PM	MAPPS Simulator Development Continuing System Development Performance Attribute Modeling Optimization with MAPPS MAPPS Applications and Field Experience
Forest Genetics	Wednesday, October 26 1:00 PM - 5:00 PM Dinner at 6:00 PM	Softwood Somatic Embryogenesis Initiation Development/Maturation Conversion Biochemistry of Embryo Development Hardwood Cloning

TABLE OF CONTENTS

AGENDA

SYSTEMS ANALYSIS PROJECT ADVISORY COMMITTEE MEETING

The Institute of Paper Chemistry
Continuing Education Center
Appleton, Wisconsin

Tuesday, October 25, 1988

12:00-1:00	Lunch (CEC Dining Room)	
1:00-1:15	Introductory Remarks	Clyde Sprague/James Bonner
1:15-1:45	MAPPS Status Report	Gary Jones
1:45-2:30	Interface Development/ Streamlining MAPPS Executive	Mike Schreiter/Mary Berceau
2:30-4:00	Progress in Performance Attribute Modeling	Gary Jones
4:00-4:30	Streamlining MAPPS Documentation and Model Development	Mike Schreiter
4:30-5:30	Marketing Issues	Gary Jones/Mike Schreiter
5:30-6:00	Cocktails	
6:00	Dinner	
7:00	*MAPPS Users Group Meeting	Jack Landin

Wednesday, October 26, 1988

7:00-8:00	Breakfast (CEC Dining Room)	
8:00	Committee Review Session (small conference room, CEC)	PAC Committee
8:30-12:00	*MAPPS Users Group Meeting (large conference room, CEC)	

*Users Group will meet with Committee and IPC staff during the afternoon of October 25.

NOTE: The spring Systems Analysis PAC meeting is scheduled for March 28-29, 1989.

SYSTEMS ANALYSIS

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9/88
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THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

Status Report

to the

SYSTEMS ANALYSIS

PROJECT ADVISORY COMMITTEE

Project 3471

PROCESS MODELING AND SIMULATION

October 25-26, 1988

PROJECT SUMMARY FORM

DATE: October 25, 1988

PROJECT NO. 3471 - Process Modeling and Simulation

PROJECT LEADER: (Report submitted by G. L. Jones)

IPC GOAL:

To develop and support a marketable computer modelling capability to cover the full spectrum of mill types and problems of interest to Institute staff and companies throughout the pulp and paper industry.

OBJECTIVE:

To develop and support the simulation capabilities required by our member companies.

CURRENT FISCAL BUDGET: $150,000

SUMMARY OF RESULTS SINCE LAST REPORT: (February 1988 - September 1988)

Tufts University has been added to the list of academic users of MAPPS. No new sales to commercial companies have been made, although several companies are evaluating MAPPS for purchase or renewal. Micro-MIP continues to generate strong interest. A new site license costing $500 for academic users was developed. Ten individual copies and two site licenses have been sold since February 1988.

MAPPS Performance Attribute System will be the subject of discussion at the informal meeting of the simulation committee of the first day of the TAPPI Engineering Conference in Chicago. A validation study paper on MAPPS and demonstrations will be presented in late September at the CPPA Simulation Conference in Quebec City.

Revision 3.1 containing corrections and updates was issued just after the last report in February. In order to improve our documentation procedures, current documentation has been transferred from CPT to the PC. Documentation will be generated on a newly purchased laser printer.

As part of our efforts to spur model development and improve efficiency, new hardware and software systems have been evaluated to replace or upgrade our existing hardware. As a result, we have initiated a purchase request for a multi-user system which would link our existing PC's into a UNIX/DOS network.

As promised, the Performance Attribute System within MAPPS has been expanded to allow simulation of property development in papermaking and chemical pulping systems. The expansion implements models described previously. The new system has undergone limited testing on several MAPPS flowsheets and results to date look quite reasonable. New data from a newsprint mill is in hand to help validate the new system. A beta test version may be available by November.

A large number of Performance Attribute related process and property models have been developed and implemented. These include modules to simulate the head box and Fourdrinier, a wet pressing module, a calendering module, blocks to initialize pulping or paper streams, modules to compute properties, property routines to compute PAT's from fiber flows, a module which initializes PAT's for a paper stream, and numerous property models.

Many existing modules have been modified to use Performance Attributes. These include stream splitters, consistency controllers, controlled splitters, clarifiers, stream conversion, generic bleaching, chlorination, alkaline extraction, chlorine dioxide bleaching, kraft pulping, generic refining, and separating.

The mechanical pulping modules for refining, mixing, screening and cleaning have also been modified to include new performance attributes which now number twenty.

Several new utility modules have also been developed to perform simple arithmetic with simulation variables, to automate simulation case studies and to calculate consistencies for given streams.

Efforts to develop a more user-friendly environment by integrating the micro-MIP stand-alone interface into the MAPPS executive have continued. One approach which appears promising would be to restructure the entire executive in C language. This approach would provide much greater flexibility and enable add-ons such as optimization, graphics, windows or dynamic simulation to be easily incorporated.

STATUS

The main thrusts of the late spring and summer of 1988 have been in three areas: performance attribute model implementation, analysis and testing of hardware and software to streamline MAPPS development and documentation, and studying ways of enhancing MAPPS "user-friendliness." While marketing inquiries have been brisk at times, there has been only limited opportunity for commercial sales. This indicates a need to reevaluate MAPPS licensing and cost structures.

Marketing Activities:

The National Council on Air and Stream Improvement (NCASI), an affiliate of Tufts University, is the most recent addition to the MAPPS academic community. There is continued interest in MAPPS by small supply or engineering firms, but they are deterred by our current pricing structure. It may be worthwhile to offer several smaller unsupported versions of MAPPS for limited applications at considerably reduced prices.

MAPPS demonstrations are planned at the upcoming process simulation symposium sponsored by CPPA to be held in Quebec City, September 27-29, 1988. A paper on MAPPS will also be presented. The performance attribute system will be discussed at the upcoming meeting of the Simulation Committee of TAPPI to be held in Chicago in mid-September. We hope to generate some controversy and interest in this novel approach.

The PAT system will be the subject of several upcoming seminars and papers. As a new direction or approach to process simulation, the PAT system will be discussed at the PIMA Conference in April 1989, the TAPPI conference in Madison cosponsored by the Forest Products Laboratory also in April, and a Friday seminar at The Institute of Paper Chemistry in February 1989.

The micro-MIP interface continues to receive considerable interest. As a result of a suggestion by Bill Scott at Miami University, we developed an academic site license agreement which allows for unlimited copies to be made within the academic institution. For the academic license, the price was increased to $500 and unlimited numbers of copies are allowed. To date, ten individual licenses have been sold at $100 each and two academic site licenses have been sold.

Maintenance Activities

MAPPS update 3.1 was sent out to users in February 1988 but was not mentioned in the previous report.

A version of MAPPS will now compile and run in the UNIX operating system installed on our AT&T PC. Maintenance and documentation procedures are being streamlined. All documentation has been transferred from CPT to PC. It is still necessary to reformat all documentation and rewrite all drawings and equations. In addition, a laser printer was purchased for improved quality and flexibility.

Several alternative hardware systems have been evaluated with the aim of upgrading the performance and efficiency of model development, as well as documentation and maintenance. The system of choice is a multi-user network available from Unisys, Prime or Tandy. The proposed multi-user system would provide the power of a 386 machine, the flexibility of both the UNIX or DOS environments without sacrificing our existing PC's. The UNIX operating system would allow for development, optimization, new applications, and multi-user model testing required for the new PAT system not possible with separate PC's. A request to purchase the equipment is currently under review.

Development Activities:

Performance Attributes

An expanded system of models has been developed in MAPPS to simulate property development in papermaking and chemical pulping. The new models include those for sheet density, isotropic and directional elastic moduli, tensile, tear, burst, brightness, scattering coefficient, absorption coefficient, rupture energy, elongation at break, porosity, opacity, and printability characteristics.

The performance attributes list now includes the following:

* four statistical parameters for length and width distributions and a fifth parameter to specify the type of distribution, i.e. log-normal, normal or Weibull.

* fiber cell wall thickness, density, modulus, and tensile

* fiber specific surface represented by K-factor and CSF (Canadian Standard Freeness)

* fiber composition represented by kappa number and yield

* a process parameter to specify property model groups

* potential relative bonded area

* actual relative bonded area
* anisotropy ratio
* formation coefficient
* absorption coefficient
* curl factor

The labyrinth of models allow for interactions too numerous to mention in detail. However, some of the more prominent interactions are described below.

The fiber cell wall thickness, density, modulus, and tensile strength introduce species effects and are influenced by pulping and bleaching. Species effects are also introduced through kappa number and absorption coefficient. These are influenced by delignification processes in pulping and bleaching. These in turn influence the conversion of hydrodynamic specific surface generated during refining into potential bonded area.

The length and width distributions are not only species dependent, but are also influenced by refining, mixing, screening, cleaning and retention on the paper machine. Length distribution and K-factor work together to determine hydrodynamic specific surface area, SH. The K-factor represents the effects of refining such as specific power and consistency on SH.

PAT's are initialized by a new data base containing species dependent information.

Yield interacts with SH to determine potential bonded area, SB. Pressure, CSF, yield and cell-wall thickness influence sheet compressibility and interact to increase SB during wet pressing. During drying, temperature and moisture interact to convert potential bonded area, SB, into actual bonded area, SA.

Reslurrying or increasing moisture content reduces actual bonded area to near zero values. Severe straining or shearing as in calendering also reduces actual bonded area. Most tensile and elastic properties depend on actual bonded area while sheet density depends on potential bonded area.

Conditions in the headbox and machine speed determine jet to wire speed ratio, JWR. This influences orientation ratio. Formation is treated as the coefficient of variation of actual bonded area which is influenced by machine speed, JWR and forming consistency. Variations in SA lead to variations in individual measured properties such as tensile, tear, elongation and burst. The average values of these properties are then increased or decreased depending on their dependence on SA.

Orientation ratio and wet stretching at the end of the Fourdrinier influence the sheet anisotropy which leads to MD/CD and ZD variations in the sheet.

Retention will vary with particle diameter or fiber length at each point along the wire. The fiber size distribution and hydrodynamic specific surface of the retained mat and the white water will vary. Drainage elements, gravity, and screen size will influence the retention and drainage behavior along the wire.

A large number of Performance Attribute related process and property models have been developed and implemented. These include modules to simulate the head box and Fourdrinier, a wet pressing module, a calendering module, blocks to initialize pulping or paper streams, modules to compute properties, property routines to compute PAT's from fiber flows, a module which initializes PAT's for a paper stream, and numerous property models.

The head box portion of the Fourdrinier model predicts jet velocity, jet-wire drag ratio, jet angle, and contraction coefficient. The wire portion, which is based on recent work by Springer (1-7), predicts the effects of wire screen size, fiber and particle size distribution, table rolls, foils and wet and dry vacuum box geometry, and operating conditions on overall and individual fiber retentions, consistencies and flows. Many of the performance attributes are affected.

The wet pressing module, which is based on the work by Wahlstrom and Caulfield (8-13), predicts the water removal and densification during wet pressing as a function of attributes and pressure.

The calendering model is based primarily on the contributions of Crotogino and Waterhouse (14-17), but also includes some as yet untested concepts. The sheet density may increase while tensile and elastic properties decrease during calendering. However, gradient calendering or supercalendering may have little influence on most bulk properties, but may influence only surface properties such as smoothness and surface strength.

The concepts of surface density and penetration distance are used to differentiate between bulk and surface effects. Penetration distance refers to the penetration of heat into the sheet during transport through the nip. Property development can be affected differently from bulk density by differentiating between actual bonded area, which can decrease under shear, and potential bonded area, which affects apparent density. These new concepts will require considerable validation and testing.

The new wood block initializes pulping, bleaching and paper streams including the performance attributes. A somewhat similar block initializes PAT's for a given paper stream. A new property block computes appropriate handsheet and machine properties on a given paper stream.

New property models enable fiber flows to be determined from PAT's or PAT's from fiber flows. A new fiber distribution, the Weibull distribution, is also being tested. Based on the work of Ullman (18) this distribution appears to fit many TMP pulps.

Many existing modules have been modified to use Performance Attributes. These include stream splitters, consistency controllers, controlled splitters, clarifiers, stream conversion, generic bleaching, chlorination, alkaline extraction, chlorine dioxide bleaching, kraft pulping, generic refining, and separating. Using these generic modules, the generic paper machine flowsheet PAPER.DAT now runs with the new PAT system.

The mechanical pulping modules for refining, mixing, screening and cleaning have also been modified to include new performance attributes. The TMP flowsheet, TMP.DAT, is being used to test the new system and compare performance with the original version.

New data from a newsprint mill are on hand to help validate the new system. Data are provided from the stone groundwood mill, the kraft mill, and two paper-machines. The data include both handsheet and machine paper properties and operating conditions. A simple generic pulp mill and bleach plant flowsheet is also being used to test the system.

Depending on the success in the initial tests, a beta test version may be available by November.

Utility Modules:

Several new utility modules have also been developed to perform simple arithmetic with simulation variables, to automate simulation case studies, and to calculate consistencies for given streams.

Streamlining MAPPS Executive

Efforts to develop a more user-friendly environment by integrating the micro-MIP stand-alone interface into the MAPPS executive have continued. One approach which appears promising would be to restructure the entire executive in C language. All the module and stream data including labels can be represented in several C data structures thus reducing the complexity of the code in the executive and eliminating many arrays.

This will pave the way for linkage with other programs and provide a natural environment for combining the micro-MIP interface with the current MAPPS editor. This approach would provide much greater flexibility and enable add-ons such as optimization, graphics, windows or dynamic simulation to be easily incorporated.

This work has only been possible by concerted efforts at understanding the C language, UNIX, and the new Windows for Data Library program.

Optimization:

It was decided to purchase the optimization library from the Design Productivity Center at the University of Missouri whose staff had developed the optimization code preferred by Ken Saffran. This code has already been evaluated extensively with MAPPS and a prototype interface developed by Saffran is already available.

We also anticipated that there would be numerous changes and upgrades to the code since the early 1980 version came out. However, to our astonishment, the newly purchased code is virtually identical to that used by Saffran. Thus the modification to the code required to run with MAPPS was already available through Saffran's work.

It is now possible to develop the interface using the properly licensed optimization code. DPC is willing to cooperate in developing a joint marketing plan where they would provide the optimization code and we the interface.

Student Work

Student contributions promise to provide an important boost to future MAPPS development. Each of the following students is working on a project potentially beneficial to MAPPS as part of their Master's degree requirements.

I am sorry to report that Bob Aloisi has bowed out in his work on developing a dynamic simulation feature for MAPPS. Apparently the design and implementation were too difficult within a two year time frame. It may be possible to recruit a student to continue this important project in this year's class.

Paul Rozik is developing a flowsheet to simulate the newsprint mill described previously. With this he hopes to test and validate the new PAT system and develop some insights into factors affecting property development.

References

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SYSTEMS ANALYSIS PROJECT ADVISORY COMMITTEE

and

MAPPS USERS GROUP

SLIDE MATERIAL

October 25-26, 1988

OVERVIEW

- MAPPS Status
- Interface Development
  /Streamlining MAPPS Executive
- Summary of New PAT Developments
- Streamlining MAPPS Documentation
  and Model Development
- Marketing Issues

MAPPS STATUS

- Considerable Interest in Package
- One new academic sale - Tufts U.
- Current pricing deters Engineering
  and consulting firms
- μ MIP continues to generate interest
  - Developed new academic site license
  - 10 copies and 2 site licenses sold

MAPPS Presentations and Demonstrations

Past

- **TAPPI Engineering Conference - Simulation Committee**

- **CPPA Simulation Symposium**
  - **TMP Mill Simulation Paper**
  - **MAPPS Demonstrations**

Upcoming

- **PIMA Conference**

- **Local Tappi Conference in Madison**

- **IPC Seminar**

- **Possibly the International Mechanical Pulping Conference in Helsinki**

Interface Development/Streamlining MAPPS Executive

MAPPS Enhanced Interface

- Goals and Objectives
- Plan for achieving goals
- Prototype displays
- Resource requirements
- Estimated completion date

GOALS

- Make MAPPS easier to learn and use
- Create a hardware-independent program
- Simplify the MAPPS executive/editor code

PLAN

Program Components

- Menu-driven command system
- Visual data entry and editing
- Defaults, prompts, and limit/error checking

Tools

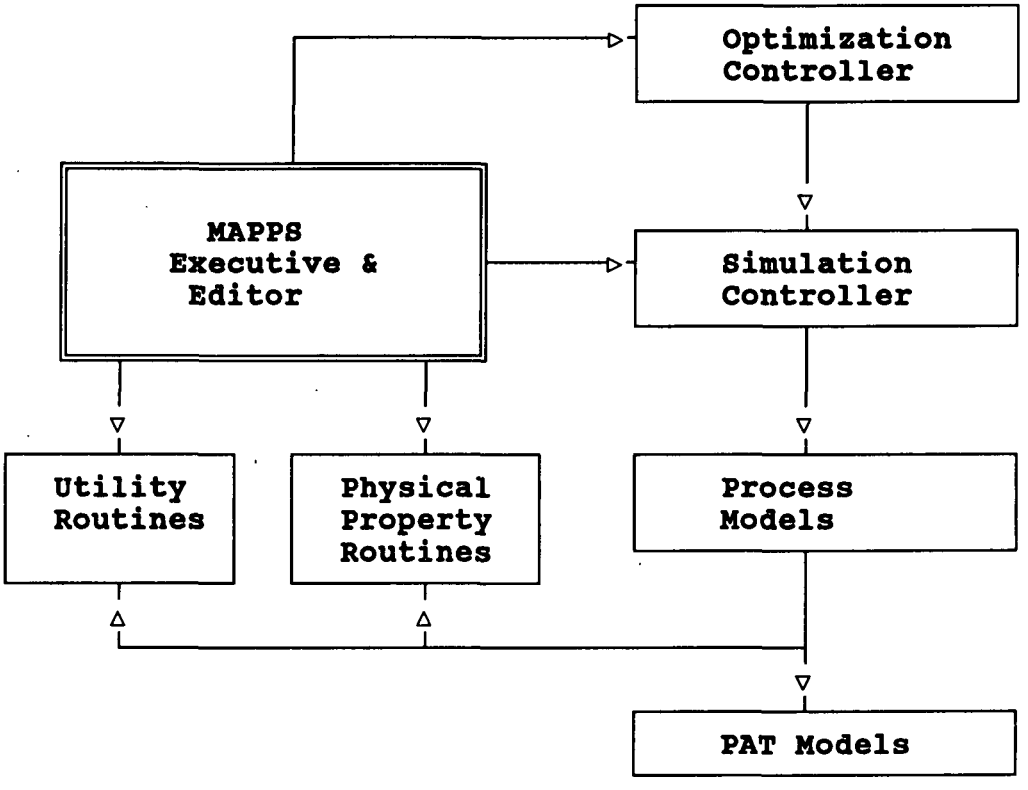
- "Portable" language that supports menus, graphics
- Commercial programming libraries

RESOURCES

- Commercial window/menu library
- C compilers
- Reference material, tutorials
- Programming tools
- Workgroup environment
- Time:
  Planning and design
  Programming
  Documentation
  Testing/Debugging

ESTIMATED COMPLETION DATE

- "Alpha" version: June 30, 1989
- "Beta" version: September, 1989

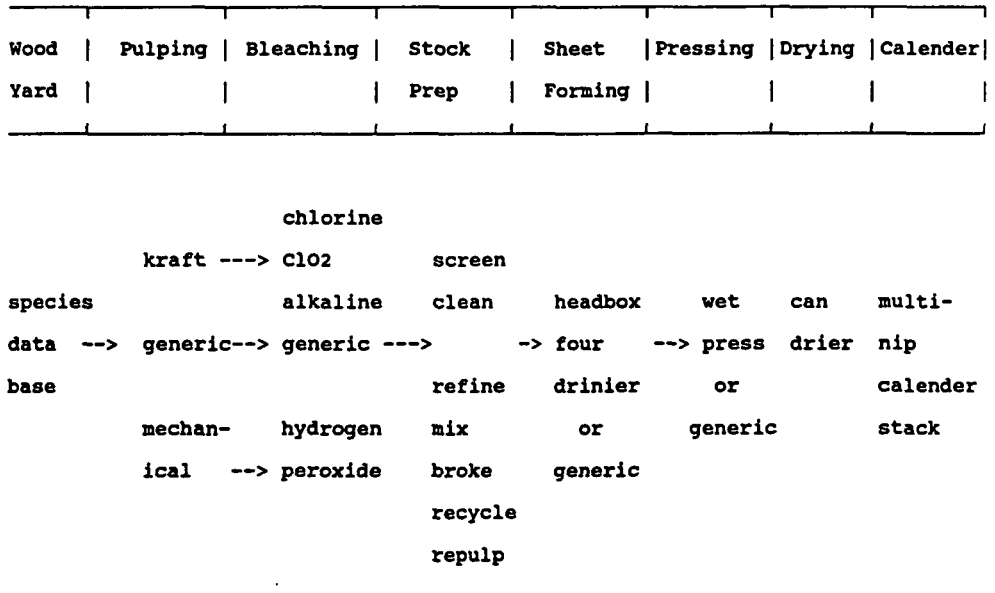

Optimization Controller
MAPPS Executive & Editor
Simulation Controller
Utility Routines
Physical Property Routines
Process Models
PAT Models

Progress in Performance Attribute Modeling

Performance Attributes

- New Modules Developed
- Significant number of modules modified
- Attribute list expanded
- Flowsheets developed
- Limited testing
- Validation underway

PAT System Process Flow



New Modules Using PAT's

- Head Box and Fourdrinier Wire Section (FOUR01)

- Single Wet Press Nip (WPRESS)

- Calendering Nip or Stack (CALEND)

- Stream Initialization Block (WOOD02)
  - Pulping, Bleaching
  - Paper Streams

- Property Block (PROPS)

- PAT Initialization Block (PAPSIM)

- Separator Block (SEPAR3)

Modified Generic Modules

- Generic bleaching (BLCH01)
- Clarifier (CLAR01)
- Controlled splitter (CONSPL)
- Generic Screening (SCRN01)
- Total flow splitter (SPLIT1)
- Consistency Controller (CONSIS)
- Stream converter (CONVRT)
- Can Dryer (DRYER1)
- Component Separator (SEPAR1)
- Refiner (REFNR1)
- Pump (PUMP01)

Modified Detailed Models

- Kraft digester (DIGR01)
- Refiner (HYRFN1)
- Screen/Cleaner/Thickener (HYFRAC)
- Stock Mixer (STOMIX)
- Bleaching Modules
  - Hydrogen Peroxide (HYPROX)
  - Chlorine (CHLORN)
  - Chlorine Dioxide (CLDIOX)
  - Alkaline Extraction (ALKOXY)

Modules Requiring Modification

- Disk Savall (SAVALL)
- Oxygen bleaching stage (OXYG01)

Other Changes

- Minor changes to Block Data, Common and PAT stream data

New Property Models

- Fiber Basic Data

- Computes fiber length and width distributions from statistical parameters

- K-factor model

- Hydrodynamic Specific Surface Area

- Canadian Standard Freeness

- Potential Bonded Area before wet pressing

- Potential Bonded Area after wet pressing

- Actual bonded area

- Light Absorption Coefficient

- Change in absorption coefficient

- Brightness

- Anisotropy ratio

Property Models (cont'd)

- Formation (bond density variation)

- Directional Properties

  - Elastic moduli C_{11},C_{22},C_{33} (MD,CD,ZD)

  - Directional tensiles ZX,ZY,ZZ

  - Directional compressive strength

  - Edgewise compressive strength

- Surface Properties (gloss and roughness)

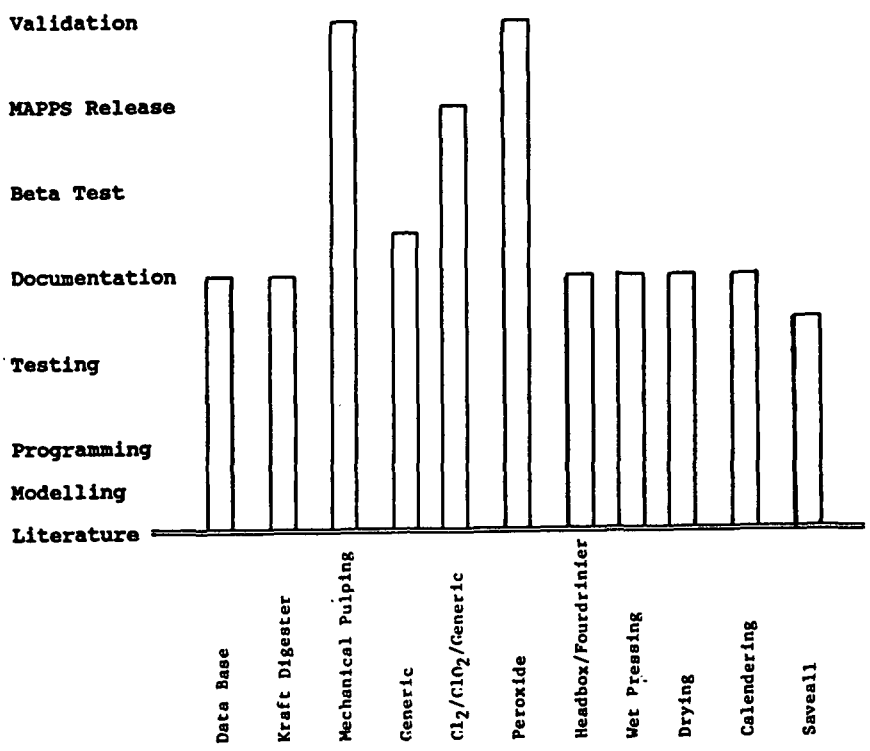
Special Utility Routines

- Computes length and width statistics from paper stream composition

- Computes distribution statistics given correlation matrix and distribution type

- Added Weibull fiber length distribution option

Status of PAT System Development



Summary of New Module Features

Wet Press Module

- Single nip continuous wet pressing operation
- Calculates rate of water removal from web
- Uses dynamic compressibility model

  - treats compressible mat as a Kelvin body responding to a compressive stress

$$M_{out} = M_{in} - M_{in}*(P/C)(1. - e^{(t/\tau)})$$

PAT's:

Potential Bonded Area S_b increases through

compressibility model

Thermodynamics:

Adiabatic, outlet pressures are atmospheric

Wet Press Model based on

- **Caulfield, Wegner, Young (main dewatering model)**
  - **water removal is dominated by transfer from the cell wall**

- **Wahlstrøm and Sweet (introduce basis weight dependence)**

P = maximum nip pressure

C = wet web compressive modulus

t = nip residence time

τ = dewatering time constant

τ = function of web flow resistance and initial moisture content

- web flow resistance is a function of CSF, basis weight and moisture content

C = exponential function of initial moisture content and independent of species and freeness

C also a function of basis weight for machine-made webs

Calendering Module

- Multiple-nip calender stack

- Determines the following:

  - bulk reduction through nip intensity factor
  - surface densification through heat penetration
  - change in bond area and bulk properties depends on relative extent of heat penetration
  - surface properties based on "surface" densification

. Contributors

- Ron Crotogino - bulk reduction as a function of nip intensity factor, NIF

NIF = function of calendering speed, nip load, roll radius and paper moisture and temperature

* nip temperature depends on approach to equilibrium

* approach depends on roll temps, wrap arrangement, speed and sheet properties and basis weight

- Charles and Waterhouse

Bulk properties such as modulus, tensile and burst increase with increasing densification to a maximum then decrease with increasing densification

- Gradient calendering involves short time, high temperature treatment which has little effect on bulk properties but influences surface properties significantly

Surface Properties

- Sheffield roughness increases from 10 to 350 as surface bulk increases from 1 to 2.3

- Gloss decreases exponentially with surface bulk

- Brightness depends on absorption and scattering coefficients
  - scattering increases with increasing surface bulk

Headbox and Fourdrinier Module

- Headbox

  - Based on Kerekes equations in Tappi J.
  - Potential flow theory

Given:	Calculates:
. Pressure	
. Slice height	. Deflection Angle
. Pond height	. Contraction coefficient
. Machine speed	. Jet velocity
. Lip extent	. Drag ratio
. Slice angle	. Initial slurry head

. Wire Section

Input data:

- **Machine dimensions**
- **Forming section length**
- **Number of each drainage element**
  - **table rolls, foils, wet vacuum boxes, dry vacuum boxes**
  - **dandy roll not yet implemented**
- **Foil length and angle**
- **Table roll diameter**
- **Wet vacuum pressure**
- **Dry vacuum pressure**

Input data:

- **Wire diagonal length**
- **Trim fraction**
- **Orientation angle**
- **Stretch in open draws, %**

Optional data:

- **wire resistance**
- **first pass particle retention**
- **diameter of suspended material**
- **density of suspended material**

Model Output:

- **Basis Weight Profile**

- **Drainage rate profile**

- **White water consistency profile**

  - **after forming board**
  - **after foil section**
  - **after table roll section**
  - **vacuum foil or wet box section**
  - **high vacuum dry box section**

- **Web**

  -fiber and moisture content

  - surface area, CSF and PAT's

- **White water**

  - fiber content and consistency

  - surface area, CSF and other PAT's

- **Sheet anisotropy ratio**

- **Formation parameter**

Model Basis:

. Elaborate filtration and particle separation process controlled by local pressure drop and flow resistance

* entering slurry split internally into three substreams

- slurry above (inlet consistency and fiber content)
- mat (retained fibers and suspended particles)

* mat consistency remains constant
* gains fibers from slurry
* losses fibers to white water

- white water

Retention:

- based on extension of Estridge model
- depends on each particle (component) in slurry
- computed at each drainage element

Local drainage rate

- In forming section based on Victory model

- Remainder based on model of Pires and Springer

- Uses Darcy and Taylor filtration equation with maximum pressure constraint (iterative solution)

Local drainage rate (cont'd)

- Local filtration resistance is a function of

  * pressure drop
  * mixture consistency
  * turbulence level

Model Verification and testing

- Debugging, robustness
- Paper machine model - literature data (Springer, Pires)
- Calendering model - Crotogino data

Model Testing and Verification

- Full mill system - newsprint mill data
  * stone groundwood mill
  * kraft mill
  * two different papermachines
- Flowsheet development
- Beta test version

Streamlining MAPPS Documentation and Model Development

MAPPS Documentation

- Goals and objectives
- Plans for achieving goals
- Resource requirements
- Estimated completion dates

Documentation Goals

- Streamline the documentation process
- Improve the quality of MAPPS user documentation
- Improve the quality of in-house program documentation

Documentation Plans

- Designate a "Documentation Specialist" within the group
- Develop and use Style Guides for all documentation
- Use the PC to generate and store all documentation
- Continue with transfer of existing module documentation to the PC
- Integrate documentation projects with systems development projects

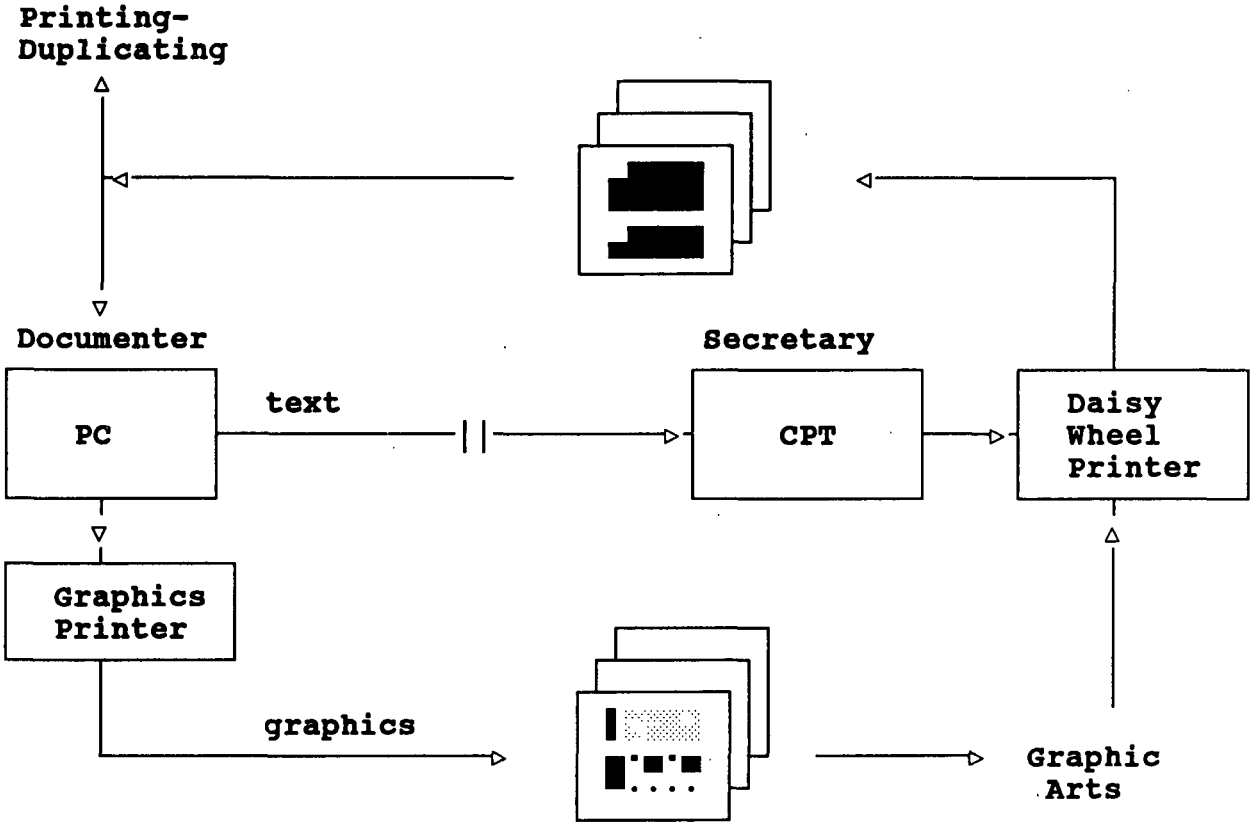
Documentation Resources

- "Documentation Specialist"
- Documentation style guides
- Project management tools (software)
- Integrated work-group computing environment
- User input
- Time:
  Planning
  Style guides
  Functional requirements
  Writing

Estimated Completion Dates

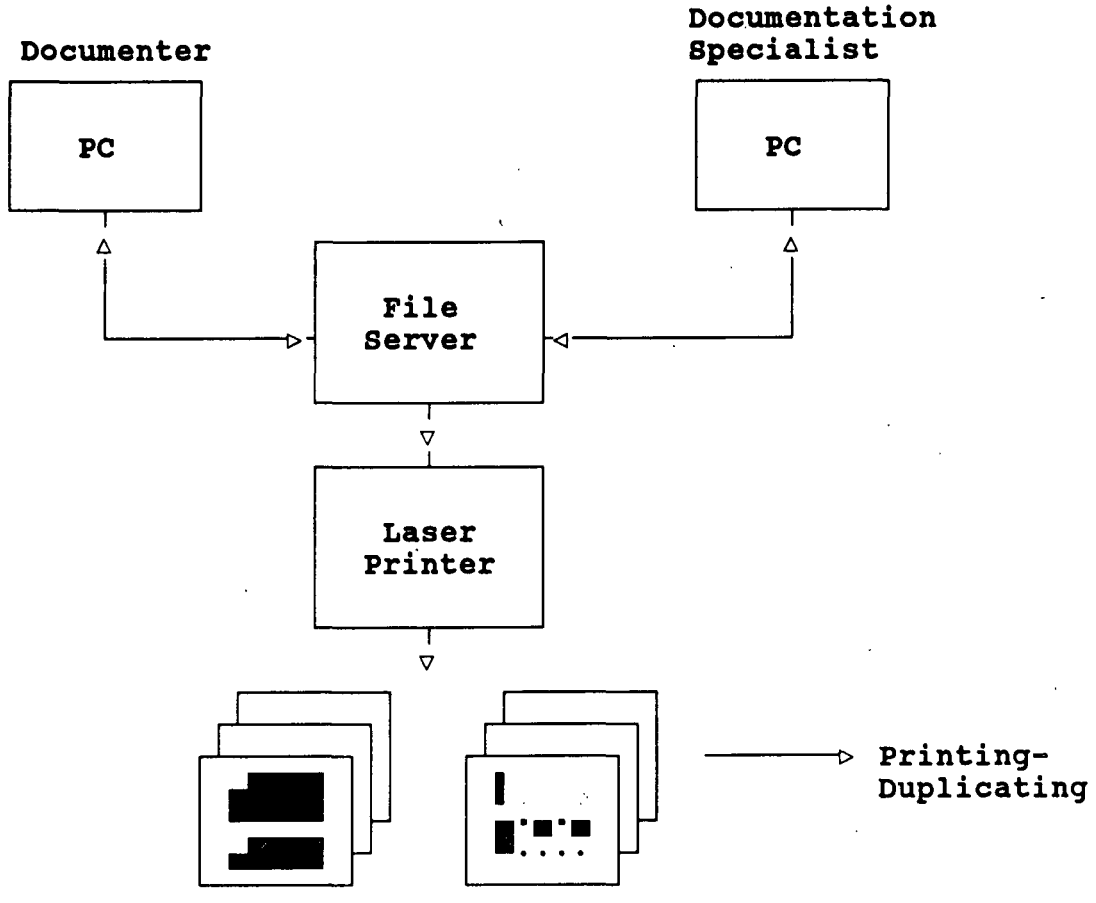
- Dependent on progress of systems development project
- Planning, style guides, functional specifications completed by December 31, 1988
- Transfer module documentation to PC requires technician/secretary and about 3 months full time.

CURRENT DOCUMENTATION PROCEDURES



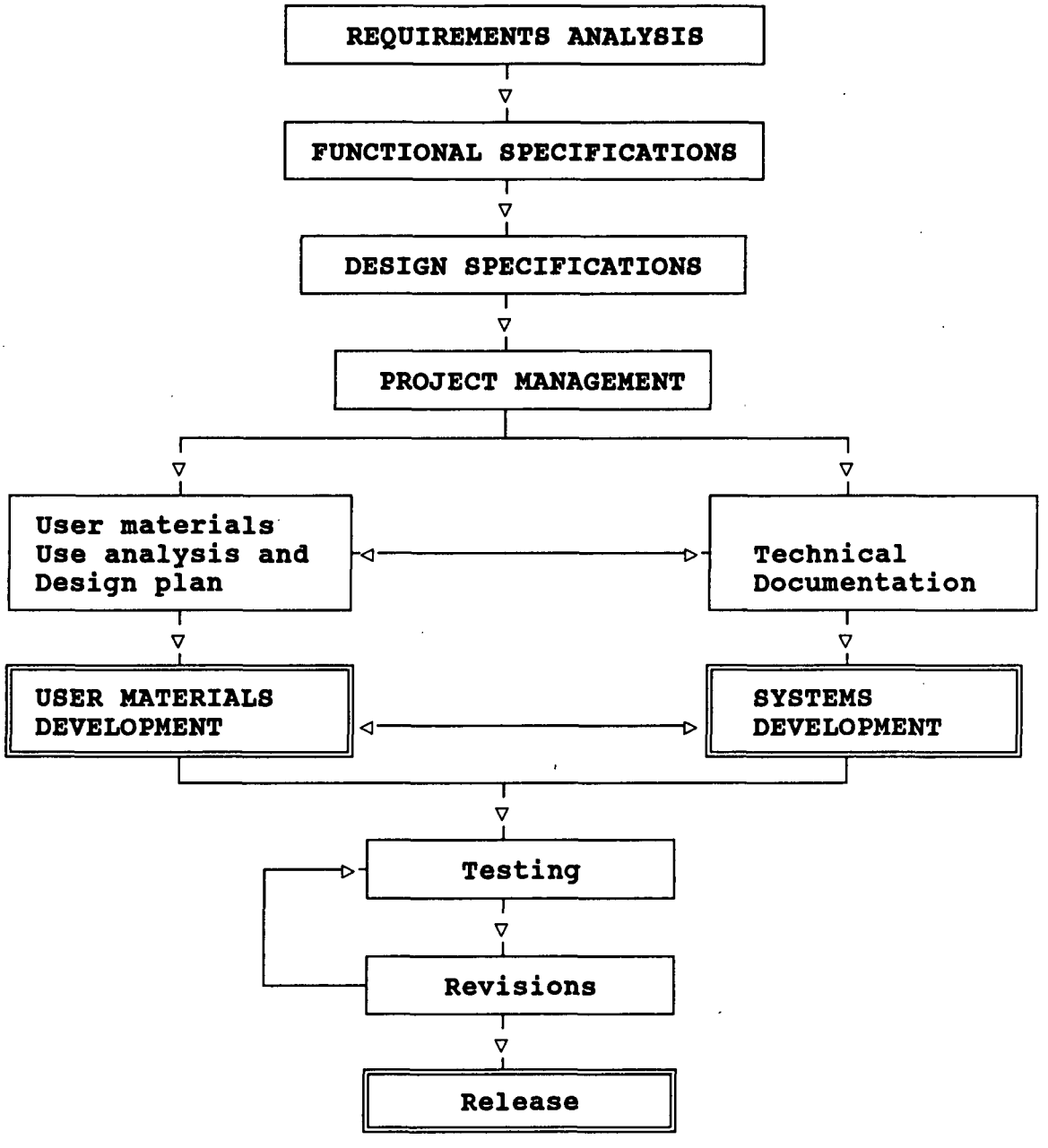
1) Generate text on a PC, graphics on PC or by hand
2) Strip all formatting and special characters from text
3) Send text via modem to secretary's CPT
4) Send graphics to graphic arts for drawing
5) Secretary reformats text, adds information to graphics
6) Print text on daisy wheel printer
7) Use special printer to enter some special characters
8) Proof read
9) Duplicate

NEW DOCUMENTATION PROCEDURES



1) Generate text and graphics on PC
2) Format, add headers, page numbers, etc. (use style guide)
3) Print on laser printer
4) Proof read
5) Review by documentation specialist
6) Update files
7) Duplicate

DOCUMENTATION AND SYSTEMS DEVELOPMENT MODEL



Student Work, Optimization, Marketing Issues

Student Work

- Dynamic simulation - Bob Aloisi
  - difficult to do correctly
  - generates high level of interest
  - both GEMS and PAPSIM (PAPRICAN) have simple versions
  - SACDA's version is much more rigorous
- PAT system validation and testing - Paul Rozik
- Some interest in current class

Optimization

- Extremely important
  - highly constrained flowsheet simulation
  - useful case studies
  - data reconciliation
- GEMS has a simple linear optimization
  - most applications of GEMS use it
- MASSBAL incorporates optimization naturally
  - more powerful than GEMS approach

Optimization (cont'd)

- Two programs under evaluation
  - Design Productivity Center (SLP, SQP)
  - Penalty function approach of Fiacco and McCormick
- Development and testing awaiting new hardware system
- Current preference is for Modification of a public code
  - eliminates third party arrangement
  - requires some knowledge of optimization

Marketing Issues

- What are our current goals?
  - Increase simulation use
  - Market penetration
  - Technology transfer
  - Increase IPC visibility
  - Services to member companies
- How well have we met the goals?

- What are our future goals?

- What should our pricing and packaging strategy be?

- Opportunities
  - establish arrangement with SACDA to market IPC module library
  - continue MAPPS effort as unique product
  - develop smaller packages at lower prices
    * steam and power
    * pulping and bleaching
    * high yield pulping